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·4528 of salt gave 1·3155 Ag Cl ; ∴ 59·94 per cent. Cl.
Chloride of ammonium would give 66·33 „
Chloride of ethylamine.......... 43·55 „

From these numbers it appears that ammonia is capable of partially expelling ethylamine from its compounds, and thus we have an explanation of the apparent anomaly of the appearance of ammonia with the ethylamine in the above-described experiments. It appears therefore that pure ethylamine may be readily obtained in the following manner. Equal volumes of iodide of ethyl, strong alcohol and ammonia are to be digested together for about half an hour, at a temperature somewhat below that of boiling water, with continual shaking ; the product of this operation boiled to expel excess of ammonia, and then distilled from potash—the distillate being received into dilute sulphuric acid, the ammonia separated by means of alcohol, and the alcoholic solution of the mixed sulphates treated with sufficient potash to liberate about $\frac{9}{10}$ of the bases present. On distilling this mixture, pure ethylamine, accompanied with alcohol and water, are the sole products found in the distillate.

IV. "On the Expansion by Heat of Metals and Alloys." By A. MATTHIESSEN, F.R.S. Received June 14, 1866.

(Abstract.)

In a paper "On the Expansion by Heat of Water and Mercury"*, a method of determining the expansion of bodies is described, by which good results can be obtained with comparatively small quantities of the substances to be experimented with. This method, that of weighing the body in water at different temperatures, has been employed for the present research. The results obtained are given in the following Tables :—

TABLE I.—Formulæ for the Correction of the Cubical Expansion by Heat of the Metals.

Cadmium......	$V_t=V_0(1+10^{-4}\times 0{\cdot}8078t+10^{-6}\times 0{\cdot}140t^2)$†.
Zinc..........	$V_t=V_0(1+10^{-4}\times 0{\cdot}8222t+10^{-6}\times 0{\cdot}0706t^2)$.
Lead..........	$V_t=V_0(1+10^{-4}\times 0{\cdot}8177t+10^{-6}\times 0{\cdot}0222t^2)$.
Tin	$V_t=V_0(1+10^{-4}\times 0{\cdot}6100t+10^{-6}\times 0{\cdot}0789t^2)$.
Silver	$V_t=V_0(1+10^{-4}\times 0{\cdot}5426t+10^{-6}\times 0{\cdot}0405t^2)$.
Copper........	$V_t=V_0(1+10^{-4}\times 0{\cdot}4463t+10^{-6}\times 0{\cdot}0555t^2)$.
Gold..........	$V_t=V_0(1+10^{-4}\times 0{\cdot}4075t+10^{-6}\times 0{\cdot}0336t^2)$.
Bismuth	$V_t=V_0(1+10^{-4}\times 0{\cdot}3502t+10^{-6}\times 0{\cdot}0446t^2)$.
Palladium......	$V_t=V_0(1+10^{-4}\times 0{\cdot}3032t+10^{-6}\times 0{\cdot}0280t^2)$.
Antimony......	$V_t=V_0(1+10^{-4}\times 0{\cdot}2770t+10^{-6}\times 0{\cdot}0397t^2)$.
Platinum	$V_t=V_0(1+10^{-4}\times 0{\cdot}2554t+10^{-6}\times 0{\cdot}0104t^2)$.

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[*] Phil. Trans. 1866, part 1.

[†] I have employed this method of writing the formulæ to prevent mistakes in the

TABLE II.—Formulæ for the Correction of the Linear Expansion by Heat of the Metals.

Cadmium	$L_t=L_0(1+10^{-4}\times 0{\cdot}2693t+10^{-6}\times 0{\cdot}0466t^2)$.
Zinc	$L_t=L_0(1+10^{-4}\times 0{\cdot}2741t+10^{-6}\times 0{\cdot}0234t^2)$.
Lead	$L_t=L_0(1+10^{-4}\times 0{\cdot}2726t+10^{-6}\times 0{\cdot}0074t^2)$.
Tin	$L_t=L_0(1+10^{-4}\times 0{\cdot}2033t+10^{-6}\times 0{\cdot}0263t^2)$.
Silver	$L_t=L_0(1+10^{-4}\times 0{\cdot}1809t+10^{-6}\times 0{\cdot}0135t^2)$.
Copper	$L_t=L_0(1+10^{-4}\times 0{\cdot}1481t+10^{-6}\times 0{\cdot}0185t^2)$.
Gold	$L_t=L_0(1+10^{-4}\times 0{\cdot}1358t+10^{-6}\times 0{\cdot}0112t^2)$.
Bismuth	$L_t=L_0(1+10^{-4}\times 0{\cdot}1167t+10^{-6}\times 0{\cdot}0149t^2)$.
Palladium	$L_t=L_0(1+10^{-4}\times 0{\cdot}1011t+10^{-6}\times 0{\cdot}0093t^2)$.
Antimony	$L_t=L_0(1+10^{-4}\times 0{\cdot}0923t+10^{-6}\times 0{\cdot}0132t^2)$.
Platinum	$L_t=L_0(1+10^{-4}\times 0{\cdot}0850t+10^{-6}\times 0{\cdot}0035t^2)$.

TABLE III.—Formulæ for the Correction of the Cubical Expansion by Heat of the Alloys.

Sn_4Pb : $V_t=V_0(1+10^{-4}\times 0{\cdot}6200t+10^{-6}\times 0{\cdot}0988t^2)$.
Pb_4Sn : $V_t=V_0(1+10^{-4}\times 0{\cdot}8087t+10^{-6}\times 0{\cdot}0332t^2)$.
$CdPb$: $V_t=V_0(1+10^{-4}\times 0{\cdot}9005t+10^{-6}\times 0{\cdot}0133t^2)$.
Sn_4Zn : $V_t=V_0(1+10^{-4}\times 0{\cdot}6377t+10^{-6}\times 0{\cdot}0807t^2)$.
Sn_6Zn : $V_t=V_0(1+10^{-4}\times 0{\cdot}6236t+10^{-6}\times 0{\cdot}0822t^2)$.
$Bi_{44}Sn$: $V_t=V_0(1+10^{-4}\times 0{\cdot}3793t+10^{-6}\times 0{\cdot}0271t^2)$.
$BiSn_2$: $V_t=V_0(1+10^{-4}\times 0{\cdot}4997t+10^{-6}\times 0{\cdot}0101t^2)$.
$Bi_{24}Pb$: $V_t=V_0(1+10^{-4}\times 0{\cdot}3868t+10^{-6}\times 0{\cdot}0218t^2)$.
$BiPb_2$: $V_t=V_0(1+10^{-4}\times 0{\cdot}8462t+10^{-6}\times 0{\cdot}0159t^2)$.
Cu+Zn (71 p. c. Cu) : $V=V_0(1+10^{-4}\times 0{\cdot}5161t+10^{-6}\times 0{\cdot}0558t^2)$.
$AuSn_2$ $V_t=V_0(1+10^{-4}\times 0{\cdot}3944t+10^{-6}\times 0{\cdot}0289t^2)$.
Au_2Sn_7 $V_t=V_0(1+10^{-4}\times 0{\cdot}4165t+10^{-6}\times 0{\cdot}0263t^2)$.
Ag_4Au $V_t=V_0(1+10^{-4}\times 0{\cdot}5166t)$.
$AgAu$ $V_t=V_0(1+10^{-4}\times 0{\cdot}4916)$.
$AgAu_4$ $V_t=V_0(1+10^{-4}\times 0{\cdot}3115\ +10^{-6}\times 0{\cdot}1185t^2)$.
Ag+Pt (66·6 p. c. Ag) $V_t=V_0(1+10^{-4}\times 0{\cdot}4246t+10^{-6}\times 0{\cdot}0322t^2)$.
Au+Cu (66·6 p. c. Au) $V_t=V_0(1+10^{-4}\times 0{\cdot}4015t+10^{-6}\times 0{\cdot}0642t^2)$.
Ag+Au (36·1 p. c. Ag) $V_t=V_0(1+10^{-4}\times 0{\cdot}4884t+10^{-6}\times 0{\cdot}0552t^2)$.
Ag+Au (71·6 p. c. Ag) $V_t=V_0(1+10^{-4}\times 0{\cdot}4413t+10^{-6}\times 0{\cdot}0130t^2)$.

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number of the zeros. I have also preferred keeping the exponents constant, adding, instead of altering them, a zero after the decimal point when required.

TABLE IV.—Formulæ for the Correction of the Linear Expansion by Heat of the Alloys.

$\mathrm{Sn_4\,Pb}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}2066t+10^{-6}\times 0{\cdot}0329t^2)$.
$\mathrm{Pb_4\,Sn}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}2696t+10^{-6}\times 0{\cdot}0111t^2)$.
$\mathrm{Cd\,Pb}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}3002t+10^{-6}\times 0{\cdot}0044t^2)$.
$\mathrm{Sn_4\,Zn}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}2126t+10^{-6}\times 0{\cdot}02691t^2)$.
$\mathrm{Sn_6\,Zn}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}2079t+10^{-6}\times 0{\cdot}0274t^2)$.
$\mathrm{Bi_{44}\,Sn}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1264t+10^{-6}\times 0{\cdot}0090t^2)$.
$\mathrm{Bi\,Sn_2}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1666t+10^{-6}\times 0{\cdot}0034t^2)$.
$\mathrm{Bi_{24}\,Pb}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1293\ +10^{-6}\times 0{\cdot}0073t^2)$.
$\mathrm{Bi\,Pb_2}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}2821\ +10^{-6}\times 0{\cdot}0053t^2)$
Cu + Zn (71 p. c. Cu) $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1720t+10^{-6}\times 0{\cdot}0086t^2)$.
$\mathrm{Au\,Sn_2}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1315t+10^{-6}\times 0{\cdot}0096t^2)$.
$\mathrm{Au_2\,Sn_7}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1388t+10^{-6}\times 0{\cdot}0088t^2)$.
$\mathrm{Ag\,Au}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1722t)$.
$\mathrm{Ag\,Au}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1638t)$.
$\mathrm{Ag\,Au_4}$ $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1038t+10^{-6}\times 0{\cdot}0395t^2)$.
Ag + Pt (66·6 p. c. Ag) $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1415t+10^{-6}\times 0{\cdot}0107t^2)$.
Au + Cu (66·6 p. c. Au) $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1338t+10^{-6}\times 0{\cdot}0214t^2)$.
Ag + Cu (36·1 p. c. Ag) $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1628t+10^{-6}\times 0{\cdot}0182t^2)$.
Ag + Cu (71·6 p. c. Ag) $\mathrm{L}_t=\mathrm{L}_0(1+10^{-4}\times 0{\cdot}1471t+10^{-6}\times 0{\cdot}0433t^2)$.

From the above the following conclusion is drawn—namely, that just as it may be said that the *specific gravity of an alloy is approximately equal to the mean specific gravities of the component metals*, so also from the foregoing we may deduce that the *volume which an alloy will occupy at any temperature between* 0° *and* 100° *is approximately equal to the mean of the volumes of the component metals at the same temperature*, or, in other words, *the cubical or linear coefficients of expansion by heat of an alloy between* 0° *and* 100° *are approximately equal to the mean of the cubical or linear coefficients of expansion by heat of the component metals.*

V. "On the Colouring and Extraction Matters of the Urine.—Part II." By EDWARD SCHUNCK, F.R.S. Received June 20, 1866.

See abstract, *anteà*, p. 1.